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EDITORIAL.

SIDNEY RAWSON WILSON.

THE world of Anæsthesia has been shocked by the untimely and tragic demise of that undoubted genius, Sidney Rawson Wilson. Barely upon the threshold of middle life, the door of success opening willingly, respected by a great community in recognition of unusual brilliance, he was just beginning to reap that reward which comes only to the few.

Wilson was a true Pioneer of Modern Anæsthesia, an anæsthesia which not long before had but emerged from the rule-of-thumb stage. The fortunate coincidence of a great interest in Physiology and allied Sciences, and an ability to apply this knowledge to Anæsthesia, brought to him an equipment for scientific investigation in this field which was of sufficient rarity to make such an indefatigable worker an outstanding character. An early prize-winning training in such subjects as Botany, Anatomy, as well as Physiology, was the foundation upon which he worked in his constant efforts to develop the practical from the theoretical, and to verify and substantiate practice by work in the laboratory.

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Wilson was not content merely to go over the ground which had already been trodden by previous workers, for he had that rare gift of vision which enabled him to look beyond the present to what is yet to be. This gift to see the light in the distance led him on along new and untried paths, ever on the outlook for that something which was to prove an advance in the art to which he had dedicated his life's work.

Who can say what Winged Victory was the vision which on that tragic day beckoned him on and which brought so promising a career to such a sad and untimely end?

To Wilson there could be no such thing as inertia in anæsthesia. The spirit which animated his entire being impelled him for ever onward in the direction of progress. He had little interest in the old and fast-dying type whose armamentarium consisted of a couple of bottles. He taught and fought, day in and day out, for the evolvement of a specialist class which would take its place worthily alongside those in other branches of Medicine. Modern anæsthesia, he urged, was broad enough to include and demand the application of a very high grade of skill and training. The ideal anæsthetist must be able by his knowledge to take over all responsibility from the surgeon for the anæsthetic safety of the patient not only during the operation but before and after. Only then would he be performing his proper function.

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Perhaps one of the most outstanding features of Wilson's character was his great faith in the future of anæsthesia as a speciality. It was to him that was first mentioned the idea of establishing a periodical to be devoted entirely to anæsthesia. He saw at a glance not only the necessity but advantage of such an innovation, and it was due to his enthusiastic support and co-operation that the first stage of the birth of *The British Journal of Anæsthesia* was passed successfully.

When at the first meeting of the newly formed Editorial Board he was persuaded to become the Honorary Secretary and Treasurer it was felt that this very important part of the work of conducting the Journal was lodged in safe hands.

At every stage in its development Wilson took a leading part, and some of its most valuable features were his suggestions. It was his idea to devote a series of articles to what he aptly termed the Pioneers of Modern Anæsthesia, papers which brought before the medical world the histories, in outline, of most of the great benefactors of anæsthesia.

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It is given to few men to have been endowed with so great a variety of mental attainment. Whether it was the practice

of Psycho-Analysis, or a demonstration of Hypnotism, or a talk on Human Physiology to students, or a lecture on the History of Anæsthesia to a mixed audience, it soon became evident that here was a man whose breadth of understanding far exceeded the bounds of his subject. As a lecturer he possessed the rare power of easily holding the attention of his auditors. Witness his talks entitled "The Physiological Basis of Hypnosis and Suggestion; The Cryptoid Phenomena; and the History of Anæsthesia. These attracted large audiences throughout the country, the latter especially being much in demand by medical and dental societies.

Which of us having heard Wilson at one of these meetings will ever forget the lightness of touch as he humorously but instructingly moved from period to period of the history of anæsthesia, with here a dab of biblical lore and there a sprinkling of ancient Greece and Rome, and then a bit of Shakespeare, delightfully entwining the sacred and mythological with the literary and scientific.

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Personally "S. R." had a delightful individuality. Those who met him only occasionally found in him a congenial companion and entertaining conversationalist. Those who knew him well discovered in him a tremendous capacity for taking pains in things worth while and an unbounded enthusiasm for all things relating to his work.

There was little of the commonplace about Wilson. For him there was more in anæsthesia than the mere production of sleep. In it was wrapped up the mystery of life and death, of dreams and wakenings, of the separation of soul from body. What were these things? When did the one begin and the other end? What was this something, placed in man's hands, which at his will wiped out consciousness and again at his will brought it back? These were the types of problems Wilson was thinking of, and, at times, trying to solve. Great and mysterious problems occupying similar minds for many years past.

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In him the world of anæsthesia has lost a great worker and his colleagues a stimulating leader. The Editorial Board

feels that it but voices the wish of all co-workers, that the name of our lamented and respected late secretary-treasurer be associated with the advance in the art upon whose altar he made the great sacrifice. To that end it has been decided to offer a prize of fifty pounds for the best research effort in anæsthesia made in Great Britain during the coming year. This will be known as the Sidney Rawson Wilson Prize.

AN APPRECIATION.

By A. H. Burgess, F.R.C.S.

The tragic death of S. R. Wilson has come as a bomb-shell to those of us with whom he was so frequently associated in the capacity of an expert administrator of anæsthetics. Devoting himself to this speciality from the outset of his career he soon established a tremendous reputation as a most careful and successful anæsthetist. He never spared himself in the slightest degree and no point arising either during the administration or in the pre- or post-anæsthetic treatment ever seemed to him too trivial to merit his earnest attention. His work inspired that perfect confidence and that absolute peace of mind of the surgeon which enabled the latter to give his undivided attention to his own department and thus to complete his operation without any avoidable trouble or delay and with consequent greater safety to his patient. With Wilson at the patient's head even the most serious operation became a pleasure to the surgeon instead of an anxiety. Wilson's help was especially sought where for any reason the anæsthetic was considered to involve some unavoidable difficulty or risk and many people, now living, owe the success of their own operation far more to his skilful administration of the anæsthetic than to the work of the operating surgeon. His calm and unobtrusive, but none the less cheery manner of reassuring his patients during the, to them, very anxious moments immediately preceding the commencement of anæsthesia must have brought them an incalculable amount of comfort, and have saved them untold

mental anguish. He had a delightful way with children, and managed to " put them to sleep " without any of those manifestations of terror and struggling not infrequently seen in less gifted and less experienced hands.

As a teacher he enjoyed a great reputation, and in the earlier years of his career was much sought after as a " coach " not only in medical subjects, but in the ancillary sciences. He had a wonderfully lucid, concise, dogmatic and impressive manner of imparting information, and one which was best calculated to ensure its retention in the memory of the students; indeed, alike at the University, the M.R.I., and the Dental Hospital he was regarded by the students as one of the most popular members of the teaching staff.

Wilson was thoroughly imbued with the true scientific spirit and was, as all anæsthetists should be, a first-class physiologist. Indeed he was never satisfied unless he could correlate the phenomena he had observed during anæsthesia with the known facts of physiology. Not only was he himself an indefatigable research worker, but he possessed in a remarkable degree the power of stimulating research in others, and many excellent contributions to physiology have been made by his assistants in collaboration with himself. Among his own researches should be mentioned his work in shock and its prevention during surgical operations, his recognition of the etiological relationship between epithelioma of the scrotum and " mule-spinning," and his recent tracing of an unfortunate series of deaths from convulsions during ether anæsthesia to impurities in the ether. He had been investigating for some time the question whether nitrous oxide produced anæsthesia by a specific action upon nerve cells, or merely by limiting their supply of oxygen, and it was whilst experimenting upon himself in this connection that the terribly tragic accident happened which deprived us of one of our most brilliant scientific workers, one of the kindest and most sympathetic of men, one whose priceless services in the relief of pain and suffering has left us all with a sense of irreparable deficiency, and one whose loss is not to Manchester alone, feel we it never so deeply, but rather to the whole and world-wide realm of anæsthesia.

ANOTHER APPRECIATION.

By W. R. Douglas, F.R.C.S.

It is not the intention of this note to describe the achievements of the late Dr. S. R. Wilson in Psychology, Physiology and Anæsthetics—branches of Science in which he was interested—but rather to draw aside the curtain a little and touch on some of his personal and intimate qualities which went to the making of his extraordinary genius. His friends, his acquaintances, and even strangers for the first time in contact, all admitted that Wilson had more than a spark of genius. Further, he was that *rara avis*-genius and hard-worker.

In his early student days he was appointed an assistant demonstrator in physiology and had the curious experience of demonstrating to his contemporaries. This appointment, which might have been deemed unwise was accepted without demur, for he was head and shoulders above the rest in this subject. This experience served to bring out his qualities as a teacher. His clear thinking, his direct, incisive method of imparting knowledge quickly gathered about him a group of keen students, less well endowed, whom he coached. In his later years he again turned his attention to the subject he loved and his appointment as Lecturer in Physiology at his University enabled him to apply his Medical knowledge to his Physiological research. Always, he emphasized the link between Physiology and his own subject.

After qualification, he began as house-surgeon at the Manchester Royal Infirmary and here he developed a keenness for anæsthetics. He disliked even minor operations and would always gladly exchange a scalpel for an anæsthetic mask. Wilson's fingers were clumsy compared to his brain.

After being house-surgeon he was appointed anæsthetist to the Royal Infirmary. This, at first, was rather slow work for him and he applied his boundless energy to coaching in all medical subjects. He gathered round him a group of

students who worshipped the ground he trod and who, although they had the greatest respect for his attainments, yet invariably addressed him by his initials. He was known throughout this town by his initials—a tribute to his immense popularity.

As his anæsthetic work gathered volume he reduced his coaching and devoted his spare moments to a new enthusiasm —Hypnosis. He quickly mastered the literature of the subject and his early experiments were tried out on the students whom he coached. His advance was rapid. He gave demonstrations and lectures to awe-struck audiences. He swept them off their feet by showing them tests which he had elaborated, including the handcuff trick of Houdini. His enthusiasm for any subject in which he was interested, made him a wonderful showman. I know of no man who could impose his personality on his audience so completely. At a medical students' smoker, at which the present professor of medicine was chairman, he gave a demonstration of Hypnosis and held an audience of medical students spell-bound. He tried a new experiment of "looking into the future" and one of his subjects, a dental student, described the "Grand National" which was to be run on the following day. He gave Sunloch as the winner by 20 lengths. This horse won next day by 20 lengths. No repetition of this experiment was successful and Wilson concluded that "transference of thought" explained the phenomenon.

His interest in Hypnosis gathered round him a group of willing helpers and his experiments, conducted at his own house behind locked doors, often carried him to the small hours of the morning. His keenness made him regardless of time, meals and sleep. After four hours sleep he was quite fit to carry on his next day's work. Later he turned his attention especially to gas-oxygen anæsthesia. He brought his knowledge of Hypnosis into play, both in the administration of anæsthetics to patients, and in his experiments on himself. Patients often expressed themselves as remembering very little of the induction.

Wilson himself was firmly convinced that he would be able to find an anæsthetic combination which would render him anæsthetic to pain and at the same time conscious of his

surroundings. As in the early days of his Hypnosis, so in the gas-oxygen experiments, his enthusiasm knew no bounds. He carried out his experiments under all sorts of conditions and whenever the chance offered itself. Although he was extremely careful in his daily work, there was in him a streak of recklessness, born of supreme confidence in himself.

Wilson was a great sportsman—he loved to take risks. He used to terrify his friends by swimming out to sea for a mile or more on a rough day without any boat or help near. His passion for sport was common knowledge. Although he had had little opportunity for playing games, yet lacrosse, football, boxing and racing had no more ardent supporter—in fact, any kind of sport appealed to him. His description of the play at the end of a football match was masterly, and there have been occasions when the professional bowed to his judgment.

He has gone from us, this super-man—for such is the appelation by which his friends, with their intimate knowledge of his protean abilities, call him. He will not be forgotten. Students will remember him for his help and kindly interest, his colleagues for his untiring efforts to improve their science, and his friends for his unswerving loyalty and devotion. A great void has been left which will not diminish with the progress of time.

AN APPRECIATION FROM AMERICA.

By F. H. McMechan, M.D.

Secretary-General, Associated Anæsthetists of the United States and Canada.

Wilson's death under such tragic circumstances has left us all aghast on our side of the Atlantic. We had learned to care for him so deeply during our few days with him and to admire him so much. His going is, indeed, an incalculable loss to anæsthesia, and we all feel that any of us could far more readily have been spared. What a shock it must have been to his dear wife, and boy and girl!

What a sacrifice to have given such a martyr to science and the relief of suffering humanity, and yet what a consolation!

They have an imperishable memory to sustain them in carrying on, and not many of us have that. The press of the whole world has carried the news. Some of the Ohio papers carried a double-column headed account.

At the Detroit Meeting, October 3—7 I will tell the anæsthetists there all about Wilson, and warn them about the danger of experimenting alone.

If I remember rightly, Mackenzie Wallis had a very close call when he and another were working with Ethanesal. The door also was locked in that instance and Wallis had been unconscious for a long time.

My heart was in my mouth most of the time that Luckhardt was working with Ethylene. He took the stuff at least 250 times under all sorts of conditions, and was in no shape to do so, physically. Fate was kinder to him.

It just seems incredible that Wilson should have had the mask on in such a way that it could not be dislodged by a fall; the wonder of it is, that more personal experimentors with gas have not done themselves in.

We can realize what it will mean to try to replace Wilson in any of his capacities. No doubt you will miss him as much, if not more than anyone else. What caught us was

the breadth of his knowledge, the keenness of his thinking, the far flung horizon of his vision, and his vitality, and withall, his humorous outlook on life and work. He was the sort you could pal with and never tire of. Some day we may realize that he has really gone. Just now I still feel that he were coming to us next year, as he had thought. Maybe it is not for all of us to go that way—like the snapping of an E string in the middle of Lifes song of songs!

Avon Lake, Ohio, September 26, 1927.

THE LATE SIDNEY RAWSON WILSON.

Born. July 13, 1882.

Educated. Penistone G. S.
Gained numerous School successes.

Entered Owens College 1900.

1901. Zoology Prizeman.
Junior Botany Prizeman.
Awarded Dauntesey Medical Scholarship.

1902. Won Tom Jones Anatomy Ex.
Junior Platt Physiology Ex.
Physiology Medal.
Was Double Senior Botany Prizeman and obtained B.Sc. Vict. 1st Class. During this year held post as Demonstrator in Botany at the Manchester University.

1903. Won the Senior Platt Physiology Ex. and obtained his M. Sc. Vict. in Physiology.

1903. In this year he gained the Scholarship Gold Medal in Materia Medica and Pharmacology, Honours in Anatomy and Physiology, prox assesit Gold Medal in Physiology in the London University Intermediate Ex. During 1902-3 he was Prosector in Anatomy, University of Manchester, and in 1903 Demonstrator in Physiology and Histology.

1904. Gained Medal for Pathology and Morbid Histology, Vict. Univ. and was Senior Demonstrator in Physiology and Histology.

1905. Obtained the M.B., B.S. Lond., taking 1st Class Honours and specially distinguished in Surgery and the M.B., Ch.B. Vict. with Honours. In this year and following years was Medical and Pathology Tutor at Dalton Hall.

1906. Appointed H.S. to the late Mr. A. Wright at Manchester Royal Infirmary.

1907. Appointed Anæsthetist Manchester Royal Infirmary; Hon. Anæsthetist Dental Hopsital; Lecturer in Hygiene, Phys. and Anat., Swedish Physical Culture School; Casualty Officer and Anæsthetist, Ancoats Hospital. Clinical Assistant and Pathologist, Christie Cancer Hospital; Surgical Tutor at Manchester Royal Infirmary and did Locum Work at Locke Hospital. It was in this year that he was awarded the Tom Jones Surgical Scholarship for his papers on Mule Spinners' Cancer, which was written in 1906.

1907. Married. In these early days earned his living by coaching students of which he made a remarkable success, many days coaching. from 2 p.m. to 2 a.m.

Rose to be chief Anæsthetist, Manchester Royal Infirmary; was also Anæsthetist to Pendlebury Children's Hospital to 1919, and Hon. Anæsthetist, Ear Hospital.

Gave lectures for British Red Cross.

1910. Obtained Degree of F.R.C.S., Edinburgh University. Took Advanced Anatomy and Physiology. (Incident of Exam.—one examiner to another who had just been giving Mr. Wilson viva—"My God—don't ask that man any anatomy.")

1914. Appointed Capt. R.A.M.C. on staff of 2nd Western General Hospital at Whitworth Street. Besides carrying on the duties connected with appointments and his military work—he was Commandant of the 5th East Lancs. Senior Red Cross Men's Detachment to whom he gave lectures in Red Cross Work and Biology. Practically all his spare time was taken up with this work, as besides teaching the men and arranging recreation evenings for them, he was constantly on train duty and afterwards air raid duty. As a slight token of their esteem these men afterwards presented him with a Silver Georgian Cup, and early Victorian Tray.

1902. His aid was solicited in the reorganisation of the Physiology Department of the University of Manchester when he was offered and accepted a lectureship in Human Physiology.

1924 (5?). Made Fellow of Royal Society of Medicine.

1925. Lecturer in Anæsthetics to University of Manchester, (the first).

June 1925. Gave Anæsthetic Demonstration in Physiology, Laboratory of Manchester University for the Anæsthetic Section of R.S.M.

Original Work.

1906. Mule Spinners' Cancer.

1907. Cardiac Rhythm—independent discovery of Auriculi. ventricular Bundle of Sheep's Heart.

1922. Cancer of the Scrotum. (With Mr. A. H. Southam.).

1922. Improved Methods of Animal Anæsthesia. (With Dr. McSwiney.).

1923. Modern Developments in Anæsthesia (in two parts).

1923. The Value of the Reflex Basis in the Interpretation of Phenomena during General Anæsthesia.

1924. Outlines of General Anæsthesia.

1926. Carbon Dioxide in Anæsthesia.

1926. Post Anæsthetic Toxæmias.

1927. A Preliminary Note on Temperature Variations During General Anæsthesia. (With K. H. Watkins, B.Sc.).
1927. Ether Convulsions.
1927. The Relation of the Physician to the Anæsthetist.

OTHER RESEARCH WORK.

Study in cause of deaths from acidosis of Children at Pendlebury Hospital, and course of preventive treatment instituted by him. Ether impurities and report to Commission.

LECTURES.

Most popular :—

1. The Physiological Basis of Hypnosis and Suggestion. (Published).
2. Cryptoid Phenomena.
3. History of Anæsthesia.

THE RELATION OF THE PHYSICIAN TO THE ANÆSTHETIST.*

By the late S. R. Wilson.

IN no sphere of practical medicine have the extra-ordinary developments in physiology and pharmacology exerted a greater influence than in the realm of anæsthetics. In the past, Bernard Shaw's jibe " that anæsthesia spares us nothing but the actual cut " may to a certain extent have been true, but it no longer applies to the up-to-date anæsthetist, who is not simply concerned with the production of unconsciousness, but with the safety, comfort, and ultimate recovery of the patient, in addition to the facilitation of the surgical procedure. Such a standard can only be attained by careful preliminary preparation, by thorough examination of the patient beforehand, and by a scientific knowledge of the immediate and remote effects of the anæsthetics concerned, both in health and disease. We are all familiar with a certain adage not infrequently repeated in lay circles with a certain amount of derision, " the operation was successful but the patient died." This statement is, to say the least, unfortunate, and the underlying sarcasm deserved, for true surgical success lies not in the performance of the operation alone, but in the cure or at any rate the relief of the patient. Whilst in desperate cases excessive risks are necessary, in others a careful estimate of the operative risk should be made. In connection with the investigation of the patient's condition, and in the evaluation and improvement of the surgical risk, it is my hope that we shall in future gain more and more help from co-operation with the physician than hitherto. Unfortunately, many medical opinions have not been too helpful in the past, and the reason of this is not far to seek. Too often the physician contents himself with saying " whether an anæsthetic should or should not be given " an attitude which conveys no real information and frequently ties our hands, for the

* Read before a combined meeting of Physicians and Anæsthetists

decision to administer an anæsthetic, and the precise procedure to be adopted, must finally rest with the specialist in anæsthesia. For this highly undesirable state of affairs, no individual blame but rather an accidental combination of circumstances is responsible. The physician's knowledge of anæsthesia largely consists of the limited instruction he received in the subject as a student and is ten to twenty years behind the times. Alternatively, the anæsthetist has not the advantage of daily association with the physician in his work and is relatively ignorant of the latest medical developments. It was an appreciation of these facts, that led me to select as the title of my paper " The Relation of the Physician to the Anæsthetist " and it represents an effort—however humble—to bring more closely together two rapidly progressive branches of medical science which have become by lack of mutual interchange somewhat widely divorced. This attempted re-union, I am sure, if allowed to develop and mature, will be for the lasting benefit not only of the two sections involved, but of general surgical progress and the well-being of the patient.

The time at one's disposal is short and the views of our medical friends so eminently desirable that I shall endeavour to express as briefly as possible the nature of the information we require, the use to which we put it, and the circumstances under which we are in urgent need of their co-operation in medical treatment.

Naturally enough, one first deals with the medium through which the anæsthetic agent is distributed to the various tissues, viz :—

The Blood.

Modern scientific developments as to the mode of action of the various general anæsthetics, tend to the belief that anæsthesia is due to a very gradual reduction in the normal oxygen supply of the living cell, and such a reduction may be effected by diminishing the supply of oxygen in the blood and tissue fluids, direct anæsthetics, (nitrous oxide, ethylene etc.), or by interfering with the capacity of the cell to utilise oxygen, indirect anæsthetics(chloroform, ether). This lowering of oxygen tissue tension if very gradually brought about

first of all produces a lessening of sensibility of the nerve cell to outside stimuli, whilst the lowlier tissues are still capable of continuing their activity. But even in their case we must realise we are approaching the threshold of tissue asphyxia. In a healthy subject the margin of safety is a fairly considerable one, but in the case of disease this margin may be considerably reduced in different vital tissues. In a normal individual the nerve cell is the first to give warning of too great a reduction in the tissue oxygen supply, but a myocardium damaged by disease and already on the verge of oxygen starvation (as shown by fatty degeneration) may suddenly cease to function and syncope result with a level of anæsthesia which may be perfectly safe to a healthy patient. We really require to know the precise composition of tissue fluid especially as regards oxygen and the factors controlling its utilisation by the cell. This, however, is asking too much in the present state of scientific knowledge. Failing this, the next best thing is to secure as much information as we can as regards the condition of the blood, particularly in relation to the oxygen carrier hæmoglobin. In all cases of severe anæmia a report of the blood condition is of the utmost importance to the anæsthetist. Any marked reduction in the percentage of hæmoglobin, whilst it renders anæsthesia easier, is lessening the margin of safety with which the anæsthetist has to work. A diminution of hæmoglobin to 50 per cent. is dangerous, and seeing that the operation may in itself effect a further reduction directly by loss of blood or indirectly by the production of shock, a hæmoglobin percentage of 60, contra-indicates the use of chloroform or of any deep anæsthesia with the indirect anæsthetics for we cannot rapidly raise the oxygen tissue tension until the anæsthetic has been excreted. With the direct anæsthetics correction of asphyxia by free administration of oxygen can be effected in about half a minute. Fortunately, these cases are very tractable and easily relax under gas and oxygen, or ethylene and oxygen, or to very weak strengths of ether vapour administered with a free supply of oxygen. Re-breathing or administration of 5 per cent. carbon dioxide with the oxygen is of extreme value for the carbon dioxide increases the capacity of the tissues to

take up oxygen. The indirect anæsthetics if pushed to a deep stage of anæsthesia or if given for prolonged periods tend to produce hæmolysis and are to be avoided or reduced to a minimum whenever the physician warns us that active destruction of red cells is taking place. Increased fragility of the red cells such as occurs in acholuric jaundice is equally a contra-indication to their use. A knowledge of the blood coagulation time is of great surgical importance at times, particularly in relation to hæmophilia and jaundice of long-standing. On several occasions in my own personal experience relatives have reported that the patient is a bleeder after the administration had commenced and whilst the surgeon was preparing his hands. If the anæsthetist can rapidly determine the coagulation time he can advise the surgeon whether it is wise to proceed immediately, and incidentally remove anxiety from the relative's minds. Many methods are available for this purpose but the most convenient and yet accurate are Dale and Laidlaw's shot coagulometer and Gibb's platinum loop. In the absence of these the glass plate method may be employed—the blunt end of a needle and the polished glass of a hand mirror being always available. The reaction of the blood, the presence of ketone bodies, and other substances influencing tissue oxidation are also of paramount importance to the anæsthetist both in the preliminary preparation of the patient and in the selection of the appropriate anæsthetic to be used in the patient's future interests—a correct decision being only possible by the mutual co-operation and agreement of physician and anæsthesia. This subject I propose to consider further in relation to the auto-intoxications. From the blood we pass to the circulation, for upon this depends the efficient distribution of oxygen to the tissues.

The Heart and Blood Vessels.

There appears to be a general impression that the presence of a demonstrable cardiac lesion is associated with a greatly increased tendency to collapse during anæsthesia, but such is far from being the case. Provided it is realised that the oxygen supply to the tissues is somewhat delayed and that less anæsthetic and a free supply of oxygen is desirable, no

anxiety need be experienced in these cases. Chloroform and propylene are not to be recommended as they appear to favour the development of heart block. Ether with a free supply of oxygen is on the whole the safest anæsthetic. Other points of importance in this connection are the avoidance of struggling in the induction stage, the elimination of cyanosis, and the estimation of the amount of surgical strain which the heart is capable of withstanding both immediately and remotely.

Miller has made an analysis of 1000 cases in order to determine the influence of demonstrable cardiac lesions on surgical prognosis. He concluded that such cases have little effect in the production of post-operative mortality. On the other hand, cases devoid of cardiac murmurs but associated with weak heart sounds, cardiac dilatation, and a low pulse pressure the post-operative morbidity is three times as great (about 12.5 per cent.)

The anæsthetist is not only concerned with the effect of the various anæsthetics upon a damaged heart, but also with the capacity of the impaired circulation to withstand surgical strain. Most valuable information in this respect is gained from :—

1. Breath-holding tests.
2. A study of blood-pressure.
3. The manometric test.

1. *Breath-holding test.*

The patient is instructed to take three deep breaths, and to hold the breath at the end of the third inspiration. If he holds it easily for 40 seconds, myocardial efficiency is present. If he cannot hold it for 30 seconds suspect cardiac inefficiency or acidosis. If he cannot hold it 20 seconds, the case is a bad operative risk whether from either of these causes. The physician can tell us wherein the defect lies.

2. *The Blood Pressure.*

The systolic pressure alone is of little value to us. Beyond a warning that we are on the threshold of cerebral hæmorrhage or thrombosis and must avoid any sudden rise of blood pressure in our technique it is useless. In any very high

blood-pressure, the choice of the anæsthetic is difficult. Ethylene has proved a valuable friend in this connection.

What we really require to know is the balance between the heart and the work it has to do. This implies details of the systolic pressure, diastolic pressure, and pulse pressure. Whilst many formulae have been devised, the one I can unhesitatingly advise after a prolonged test is Moot's Rule—

$$\frac{\text{Diastolic Pressure}}{\text{Pulse Pressure}} \times 100$$

If the resulting figure lies between 30 and 70 the patient is a good operative risk (Mortality 2-3 per cent.). If under 25 per cent or over 75 per cent. the prognosis is bad. (Mortality 20-30). Pre-digitalisation and appropriate medical treatment may transform a bad risk into a good one. Another method of arriving at a similar result is to determine the energy index:—

Systolic P. plus Diastolic P. × Pulse Rate.

120 ,, 80 × 72 = 14,400

We record the index as thousands viz., 14. An index between 12 and 18, we consider safely operable. The Manometric Test we still require more information about.

The Pulmonary System.

From an anæsthetic point of view this is a system about which we have still much to learn. Up to now the best thing is to have a physician's report in full and to be guided by it in one's anæsthetic procedure. I would, however, like to draw attention to a fallacious impression amongst many medicals that post-operative pneumonia is due to ether. Time will not permit detailed discussion but the subject has been well dealt with by Featherstone of Birmingham in the *British Journal of Surgery*. The great cause is the abdominal operation.

The Auto-Intoxications.

This is the class par excellence in which the physician is a necessity to the surgical team. Not only in respect of providing information for the anæsthetist, but because his pre-operative treatment enormously reduces the surgical risk, and

his post-operative treatment is the most vital factor in the ultimate recovery of the patient. No more brilliant example of this is to be found than in the extra-ordinary development of surgical treatment in diabetics. By intimate co-operation with the physician and an appropriate use of the newer anæsthetics the post-operative mortality has been practically reduced to that of a normal person.

The auto-intoxications in which we specially need medical help, advice and treatment, are exopthalmic goitre, all forms of acidosis, diabetes, vomiting of pregnancy.

We want tests of hepatic insufficiency to guide us in our choice of anæsthetic. The surgeon has from force of necessity developed tests of renal function.

In conclusion, may I ask for the Physician's co-operation in rendering surgery more safe. I have tried to show that we are more intimately associated than one might superficially think. There are some who maintain that the anæsthetist should study medicine from this point of view. I quite agree that in routine cases, he should be capable of doing this just as is the general practitioner, but his knowledge in this respect can never compare with that of the medical specialist and in all cases of doubt and difficulty the anæsthetist should not hesitate to secure extra help in the interests of the patient.

Should this paper lead to future meetings between physicians and anæsthetists it will not have been in vain.

REGIONAL ANÆSTHESIA FOR ORTHOPÆDIC OPERATIONS UPON THE SPINAL COLUMN.*

By GASTON LABAT, M.D.

THE principles involved in the induction of region anæsthesia for orthopædic operations upon the spinal column are, to a certain extent, different from those underlying the injection technique for operations on the other parts of the body. Injections are here, as a rule, made in regions in which the landmarks have been more or less distorted by trauma or disease.

In certain pathological conditions, the normal aspect of the spine is not only altered in the affected segment, but the entire height of the vertebral structure reacts to the partial static deficiency by compensatory displacements. Distortions vary not only with the type of the lesion, but also with the level of the spine at which it occurs. Compensatory curves are established which occasionally lead to angular deformities. In certain lateral curvatures the spine is twisted; the vertebrae and ribs, drawn in this rotatory excursion, assume abnormal directions and relationships. The position of the patient on the operating table not infrequently adds another element to these anatomical distortions. Tenderness of the region occasionally makes palpation difficult and definition of the landmarks inaccurate. The soft parts and the bony framework lose their normal relationships and the success of the anæsthetic procedure depends mostly upon interpretation and visualization. Correct interpretation is based upon a careful analysis of the features presented by the X-ray pictures of the pathological areas and their adjacent territories. Accurate visualization rests upon a thorough knowledge of anatomy and the ability to see, so to speak,

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through the overlying fleshy parts, the structural alterations resulting from the traumatic or pathological disturbances under consideration.

Anatomical Excursion.

In man, the number of vertebrae in the cervical region is almost invariable, but the curve of the cervical column and the "occipitocervical angle" vary greatly in different individuals. The thickness of the soft structures of the back of the neck, beneath which landmarks are deeply buried, is ordinarily greatest at the level of the first two vertebrae, i.e., the atlas and the axis. The atlas and the axis differ markedly from each other and from the remaining cervical vertebrae, not only in their respective morphology, but in the topographic relationship which they bear to each other and to the neighbouring structures.

The atlas is composed of two lateral masses connected anteriorly and posteriorly by two arches, it has no body. On the outer side of each lateral mass is the transverse process, long and projecting laterally with its foramen which gives passage to the vertebral artery. Of the two arches the posterior assumes greater importance both from the standpoint of the injection technique and from that of the operative procedure. Its root is grooved by the vertebral artery which crosses it on its way to the foramen magnum.

The axis has doubled its body by borrowing that of the atlas to form the odontoid process. This process articulates in front with the anterior arch of the atlas and behind with the transverse ligament. It laminae are thick, its spinous process heavy and projecting behind the third. Its transverse processes are short and small and its vertebral foramen replaced by a short canal curved upward, outward and slightly backward. The transverse processes of the other five cervical vertebrae are short and thin with an anterior and a posterior tubercle. They are shaped like a gutter in which lies the anterior primary division of the nerves. They slant downward, outward and forward and are almost hidden by the lateral masses or articular processes when the cervical column is considered from the back. Each has a transverse foramen through which pass the vertebral artery and veins.

The vertebral artery assumes an almost vertical position in its ascent through the foramina at the base of the transverse processes of the 6th, 5th, 4th, and 3rd cervical vertebrae, lying in front of the anterior primary divisions of the cervical nerves. On reaching the axis the vertebral artery passes into the transverse canal of the axis just described and curves outward and slightly backward, then upward and enters the transverse foramen of the atlas. As it emerges from this opening, it curves backward and inward around the posterior aspect of the lateral mass and lies in the vertebral groove on the posterior arch of the atlas. It then pierces the posterior occipito-atlantal ligament and enters the spinal canal.

The posterior occipito-atlantal ligament extends between the foramen magnum and the arch of the atlas with an opening for the entrance of the vertebral artery. The posterior atlanto-axial ligament extends between the arch of the atlas and that of the axis; these ligaments differ from the ligamenta subflava in that they are not elastic.

The posterior arch of the atlas, the laminae and spinous processes of the axis and of the five last cervical vertebrae constitute the deepest plane of the posterior region of the neck. These bony arches are separated from one another by spaces which are closed by the ligamenta subflava. Between the occipital bone and the atlas; between the atlas and the axis; these spaces are particularly large, the more so in extreme flexion of the head. The laminae of the cervical vertebrae are in overlapping position only below the axis so that the first two interlaminal spaces are in direct relation to the soft structures overlying them. The cerebellum and the medulla oblongata which correspond to the occipito-atlantal space, as well as the cervical spinal cord which begins at the atlanto-axial ligament, are thus exposed to injuries by the point of the needle.

Trauma to the vertebral artery is almost impossible in the region below the axis; but between the axis and the atlas, it can be reached on the outer side of the lateral masses in the open space between the transverse process of the axis and that of the atlas, where it lies in a vertical position. The vertebral artery can still be more readily reached between the

atlas and the base of the skull, because of its close proximity to the posterior aspect of the lateral mass and the posterior arch of the atlas against which it rests horizontally. It is there directly exposed to the point of the needle approaching the deep landmarks.

In the dorsal region the spinous processes, normally situated in the middle line of the back, serve as superficial lankmarks in paravertebral block. The transverse processes are thick tubercles which articulate with the ribs at a distance of about from 3 to 4 cm. from the middle line. The part of the rib just lateral to the transverse process is ordinarily used as a deep landmark for approaching each nerve as it leaves the intervertebral foramen.

In the lumbar region, the spinous process bears a constant relationship to the transvere processes of the same vertebra, its upper margin being in line with these processes. Distortions are here less disturbing than in the dorsal region. In the lumbosacral region, the lack of fusion of the 1st sacral with the 2nd sacral vertebra is not infrequently encountered. Incomplete sacralization does not interfere with the injection technique generally adopted for blocking the lumbar and sacral nerves. Sometimes a loose first sacral is interpreted as a 6th lumbar vertebra; it is then considered in the same light as the other lumbar vertebrae. It could, however, be treated like a first fused sacral vertebra if its relationship to the ilium were closer than with the lumbar column.

In a general way, the posteror primary divisions of the cervical, dorsal and lumbar nerves emerge between the transverse processes and course backwards towards the operative field. From the standpoint of the surgical procedure, they are the only ones that need be blocked, since they are the exclusive paths of sensory impulses starting from the operative field. Experience proves, however, that the blocking of the anterior primary divisions as well is necessary in order to give better comfort to the patient during the jarring manœuvres upon the spine.

The sacral nerves are injected by the transsacral method. They can always be reached through the posterior sacral foramina, both divisions being injected at the same time.

It is unnecessary to give a caudal block, unless the coccyx be involved in the operation.

All these elementary anatomical considerations are of importance to the regional anæsthetist for the reason that he must take his superficial landmarks with great accuracy in order to be able to reach the deep landmarks with comparative ease and safety. In approaching the deep landmarks he must know what are the dangerous zones in each segment of the spine and how to avoid them, particularly when distortions are present .

It has been our privilege to anæsthetize a certain number of patients operated upon at the New York Orthopædic Hospital during the last five years for lesions involving each region of the vertebral column. We have selected a few of these cases to illustrate the subject of this paper which can best be discussed by giving the details of technique employed in each case. We shall also describe such steps of the operation as will help realize the extent of the manipulations which were accomplished painlessly.

Resection of the Posterior Arch of the Atlas.

A case of unusual interest is that of a young man, 16 years of age, who on July 29, 1922, in diving, struck his head. He became paralysed and was unable to use his limbs. He was treated at Coney Island Hospital where a plaster cast was applied on the neck for 18 days. On October 21, 1922, he was seen at the New York Orthopædic Hospital and the diagnosis of dislocation of the 1st cervical vertebra was made and confirmed by X-ray examinations. The atlas and the odontoid process appeared to be dislocated anteriorly on the axis. On November 27th, because among other severe symptoms of compression of the spinal cord, of the presence of laboured breathing and the frequency and severity of the respiratory disturbances, resection of the posterior arch of the atlas was advised and probably also fusion of the first two cervical vertebrae. Regional anæsthesia was recommended because of the danger of struggling while going under or coming out of general anæsthesia.

Examination of the posterior aspect of the neck revealed the presence of a marked prominence in the upper cervical

region, due probably to the distortion caused by the forward displacement of the 1st cervical vertebra. The neck was rigid; motion limited more especially rotation and lateral bending. There was marked fulness of the muscular structures around the affected area and the muscles were stiff.

It was first decided that the atlas would be approached by a middle line incision, about 4 inches long and extending from the external occipital protuberance downward. The posterior primary divisions of the cervical nerves supply the posterior aspect of the neck as well as the occipital portion of the head. These nerves are best reached by depositing the solution in close contact with the lateral masses of the vertebrae and the base of the skull; no attempt being made to reach them individually.

The spinous process of the 6th cervical vertebra was quite palpable; it was used as a basic superficial landmark for the selection of the sites of puncture above that level. Two intradermal wheals were raised, one on each side of the process at approximately 3 cm. from the middle line of the nape. Two other wheals were raised, one on each side, midway between the external occipital protuberance and the base of the mastoid process. Along the vertical lines joining the upper wheals and the lower ones and proceeding from below upward other wheals were raised about 2 cm. apart from each other.

A needle (the 50/7 of our set) unattached to the syringe was introduced through each of these wheals in succession and advanced along a postero-anterior plane until bony contact was felt, which we expected was the row of lateral masses. Considering the nature of the skeletal lesion and due regard being had to the anatomy of the region, extraordinary precautions were taken in approaching the first and second cervical vertebrae. The syringe was connected to the needle after each bony contact had been taken and injection was made of 5 c.c. of a 0.5 per cent. solution of neocaine to which 10 drops of adrenalin solution 1 : 1000 had been added to the 100 c.c. prepared beforehand. Injections were then made fanwise in the antero-posterior plane passing through the sites of injection and the sites of puncture involving the entire thickness of the soft structures traversed by the needle.

These fanwise injections not only completed the anæsthesia started by the deep injections, but served to reduce bleeding to its lowest term.

All operative procedures were painless except when sponging, making pressure against the dura. This caused sharp pains in the trunk and legs and caused the legs to jerk.

There was very little hæmorrhage. The anæsthesia was perfect, except when pressure was applied to the dura and cord. The patient otherwise felt quite comfortable and read a newspaper during the entire operation.

Spinal Fusion from D^7 to L^2.

In the case of T. W., female, aged 30 years, the spinal column presented a sharp kyphos in the lower dorsal region, extending from the 9th dorsal to the 2nd lumbar vertebra with apex at the 12 dorsal. Spasm, rigidity and pain added to the difficulty experienced in defining the landmarks.

X-ray examination had revealed the left diaphragmatic pleura elevated by a large mass about 6 by 6 inches centered at the 8th rib posteriorly, apparently an abscess.

Anæsthetic Procedure:

Two elements here conspired against the success of the operation, namely: (1) the precarious condition of the patient and (2) the extent of the operative field, for which an enormous dose of fluid would be needed to produce adequate anæsthesia. In consideration of these disadvantages, it was decided to use a weak solution of neocaine and to increase the dose of adrenalin usually employed. Injection was made of 225 c.c. of the 0.5 solution of neocaine containing 30 drops of adrenalin solution 1:1000. The dorsal and lumbar nerves were blocked individually from D^6 to L^3 by modified paravertebral technique. The needle was introduced 3 cm. laterally to each spinous process and advanced in a postero-anterior direction towards the transverse process with which it came in contact rather easily. The needle was then passed above and tangentially to the transverse process to a point in the dorsal region 1 cm. and in the lumbar region 2 cm. deeper than the posterior surface of that process. Attempt was made to pass the needle over the base of the transverse process rather than its tip. Injection of 5 c.c. of the 0.5 per

cent. solution of neocaine was made in each intertransverse space. Through the same sites of puncture, fanwise injections completed the anæsthetic procedure. These were carried in an antero-posterior plane and involved the entire thickness of the overlying soft structures comprised between the transverse processes and the skin. A subcutaneous infiltration along the two vertical rows of puncture and another joining the upper wheals transversely was the last step of the technique. In making the paravertebral injections pus was aspirated twice, once at the level of L^1 on the right side and the second time at the level of D^8 on the left side.

The injections were made slowly and the patient closely watched. Considering the poor shape in which she appeared on the operating table and the amount of solution needed to ensure complete anæsthesia of such a wide operative field, the reaction was slight and in no way influenced the postoperative prognosis. The patient had had no preoperative narcotic medication. There was a short period of nervousness accompanied by rapid pulse and light cyanosis of the lips, ears and nails. These circulatory disturbances, aided by adrenalin and exaggerated by her tuberculous condition, cleared up while the operation was being completed. The patient returned to her room feeling as well as when she left it.

Spinal Fusion From D^{12} to L^4.

On physical examination, F.R., male, 40 years of age, was thin, emaciated and had the typical appearance of active pulmonary tuberculosis. There was limited extension of the right thigh and a large soft mass was present in the right iliac fossa. Posteriorly, the lower dorsal and lower lumbar regions were prominent. There was no definite kyphos, but the spine was right throughout with accompanying defensive contracture of the adjoining muscles.

Anæsthetic procedure:

Bilateral paravertebral block of D^{10} to L^5 was accomplished with 100 c.c. of 1 per cent. neocaine solution containing 12 drops of adrenalin solution 1:1000. This was followed by a field block consisting of fanwise injections

through the rows of paravertebral punctures, using 100 c.c of the 0.5 per cent. solution of neocaine containing 10 drops of adrenalin solution 1 : 1000.

The patient's condition was very good, although his pulse rate increased from 110 to 135 during the induction of anæsthesia. It came back to normal a few minutes later. There was no cyanosis of the lips and ears, but his nails were slightly bluish; this being explained by the deficiency of his pulmonary circulation as a result of tuberculosis. On being questioned the patient said that he felt quite comfortable. The anæsthesia was perfect.

Spinal Fusion from L^2 to S^1.

E. T., a female, 34 years of age, had a very moderate lumbar and left thoracic scoliosis. The lower lumbar and sacral areas were tender. X-ray examination revealed the presence of a thin disc between the 4th and 5th lumbar vertebrae. The 5th lumbar vertebra was subnormal in height and the spinous processes of L^4 to S^1 were in abnormally close relation. The body of the 1st sacral was not firmly fused to to the 2nd vertebra.

Anæsthetic procedure.

Paravertebral block was performed from L^1 to L^5 and transsacral injections made of S^1 and S^2 according to the usual technique, using 100 c.c. of the 1 per cent. neocaine solution cantaining 10 drops of adrenalin solution 1 : 1000. Field-block through the paravertebral wheals completed the anæsthetic procedure. This was made with 100 c.c of 0.5 per cent. solution of neocaine. The anæsthesia was very satisfactory; the patient complaining of practically no pain except when undue force was used in retracting. He had a few vomiting spells during the operation, but left the table in good condition. There were no post-anæsthetic disturbances.

Spinal Fusion from D^6 to D^{12}.

In this case of Pott's disease, there was a small kyphos at the 9th dorsal spine. Muscle spasm was quite marked in this area. There existed also in the lower extremities a degree of flexion in the one leg and a painful condition in

the other which rendered the supine position impossible. The patient was placed on his right side, the frontal plane of the body making with the table an angle of about 45 degrees. He was injected and operated upon in the same position.

Anæsthetic Procedure:

Paravertebral block was performed from D^6 to L^1 with 0.5 per cent. neocaine solution containing 10 drops of adrenalin solution 1:1000 per 100 c.c. Bilateral field-block was then made with a solution of the same concentration, using in all 150 c.c. This included a subcutaneous injection along the rows of intradermal wheals raised on each side of the spinal column to approach the nerves individually and one joining the first upper wheals transversely. Because of the position of the patient injection on the right side was more difficult than on the left. The number of nerves to be blocked and the extent of the operative field, namely, from D^5 to L^1 suggested the use of a 0.5 per cent. solution of the anæsthetic drug; the poor condition of the patient made the injection of a comparatively small amount imperative. Only 5 c.c. was deposited at each of the 18 nerves supplying the operative field, leaving 60 c.c. for distribution in the tissues according to the field-block procedure already described.

The anæsthesia was satisfactory but not as complete as desirable. Jarring of the spine was painful and throughout the operation the patient felt much discomfort on account of his position. The anæsthesia was light and lasted only about three quarters of an hour; subsequent injection of the soft structures being necessary to permit closure of the wound without pain. There was no reaction to the anæsthetic drug and the patient left the table in fair condition.

Comment.

The few cases in this paper serve not only to illustrate the use of regional anæsthesia for orthopædic operations upon the spinal column, but allow of certain inferences being drawn concerning the practical value of the method.

The supine position with the patient lying flat on his stomach is the best, because this position facilitates the paravertebral injection technique and keeps the muscles of the

back as relaxed as the skeletal disturbances permit. Lateral distortions are thus avoided and the patient feels more comfortable, particularly when some of the vertebrae suffer from abnormal mobility. An example of the discomfort caused by lateral position is shown in our last case.

The anæsthetic solution employed needs careful consideration both as regards its concentration and the quantity injected. In advanced tuberculous conditions, it is advisable to use a 0.5 per cent. solution even in paravertebral block. As high as 225 c.c was injected in one of our patients with a reaction that gave us no concern and did not justify the administration of any treatment, not even a cardiac stimulant. When the quantity of the 0.5 per cent. solution was reduced to 150 c.c. in our last case, for the injection of an equally extensive field, the anæsthesia was weak both in quality and duration; but there were no circulatory disturbances of any kind. Analysis of these two cases shows that we should not sacrifice perfect anæsthesia to the possibility of a brief period of circulatory reaction which if it should occur has no clinical significance. Of course there is a limit to the use of the 0.5 per cent. solution, and this we would, in these particular cases, fix at 250 c.c when injection is made very slowly.

The use of large amounts of adrenalin does not seem to help when the blood pressure is low. Those suffering from pulmonary tuberculosis have a defective circulation which far from being benefitted by the adrenalin mixed with the neocaine solution, turn slightly bluish from peripheral asphyxia. The blood oozing from the operative wound may at times be dark. It is now recommended to add but 5 drops of adrenalin solution 1 : 1000 to each 100 c.c. of the anæsthetic solution injected. This is quite sufficient to delay absorption, strengthen the anæsthesia and increase its duration.

The modified technique of paravertebral block by which the nerves are approached from a point overlying the transverse process is recommended because the same wheals are used for the field-block which is associated with the paravertebral block. In making the barage as close to the middle as the operative technique permits, forcible retraction causes no discomfort and part of the injected fluid finds its way

through the wound. The best advantage derived from the narrow field-block is certainly the ischemia of the operative field which facilitates dissection. No attempt was made to use the regional method for operations on children.

Conclusions.

Orthopædic operations upon the spinal column are all amenable to the regional method, provided that the injection technique be considered in the light of individual anatomical distortions. A thorough knowledge of anatomy is the prerequisite of the anæsthetist.

Decompression of the cord at the level of the 1st and 2nd cervical vertebrae is rendered less difficult and certainly less hazardous when regional anæsthesia is the method employed. The use of regional anæsthesia for similar operations at lower levels of the spine can be made with great advantage to both surgeon and patient.

Extensive spinal fusions are made possible with little or no post-anæsthetic disturbance, and the prognosis of these operations is greatly improved, particularly when active tuberculosis of the lungs is present.

Discussion of Dr. Labat's Paper.

Dr. Livingston: Nothing could better prove the desirability of having special regional anæsthetists than the masterly description of Dr. Labat of the minute anatomy of the spinal column and the adjacent tissues. The special knowledge of detailed anatomical data required for these injections demands a specialist of the highest order. This explains why many surgeons now interested in regional anæsthesia, who must make their own injections, are most anxious to resign in favour of those whose time allows them to study the methods more carefully. It is greatly to be hoped that the time will soon come when each large hospital will have its trained regional anæsthetist. In its work of advancing the art of regional anæsthesia the American Society is anxious to do all in its power to bring about such a situation.

THREE YEARS EXPERIENCE WITH REGIONAL ANÆSTHESIA AS APPLIED TO UROLOGICAL SURGERY.*

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THE institution and progress made in regional anæsthesia has been the greatest advance in the past twenty-five years especially in urological surgery. There is considerable variation in opinions as to the method of administration and the drugs used, but we are striving for a standard suitable for most cases which can be used with the greatest safety, simplicity and satisfaction.

DRUGS USED.

The drugs used by us for urological operations have varied from time to time. At first, small amounts of adrenalin mixed with novocain 1 or 2 per cent. was used. We discontinued this because the shock was greater and the anæsthesia was not augmented. Furthermore when adrenalin is used many small bleeders are overlooked because of the vaso-constriction of the drug, and we would rather have them bleed, clamped and tied at the time of operation than ooze when the effect of the drug has disappeared. Sodium bicarbonate mixed with novocaine clinically did not improve our anæsthesias. The use of hyoscine was stopped because of some severe reactions which prevented us from even administering regional anæsthesia. We have used small amounts of colonic ether in oil, as well as Gwathmey's analgesia of 2 c.c. of 50 per cent. magnesium sulphate solution containing 2.5 per cent. novocaine and $\frac{1}{3}$ gr. morphine for 3 doses at half hour intervals before operation, without

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materially aiding the anæsthesia. We believe that by using preliminary morphine or other analgesias, except in unusual cases where the mentality of the patient must be considered, we are admitting that the regional anæsthesia in itself is not complete, besides adding another toxic element to the patient. A synthetic anæsthesia called Anetin was tried because of its very low toxicity, but the anæsthetic properties were not sufficient. Novocaine 2 per cent, 1 per cent. and 0.5 per cent. has been used at various times. One per cent. novocaine is practically as efficacious as 2 per cent., while 0.5 per cent. novocaine is distinctly inferior for most uses. It is preferable to use larger volumes of a 1 per cent. than smaller quantities of a 2 per cent. solution. Freshly prepared 1 per cent. novocaine in normal saline solution is used except when large quantities are necessary or the patient is a poor surgical risk. In such cases 0.5 per cent. novocaine is indicated. The maximum of novocaine used is the equivalent of 100 c.c. of 1 per cent. solution (1 gram of the salt) to 100 pounds of body weight.

Rapid and extreme deep respiration during the operation materially aids the anæsthesia, probably because it helps stabilize the patient's mental condition and produces rapid tissue combustion which results in a sense of imperviousness to pain.[15] Furthermore, the threshold of painful stimuli varies considerably with individuals.

Methods of Administration.

Sacral anæsthesia is used for minor perineal operations and cystoscopies, but this is augmented by transsacral anæsthesia for perineal prostatectomies. The method described by Labat[16] for locating the foramina is usually used although the equilateral triangle of Haines[14] is occasionally helpful. The syringe and needles devised by Labat are entirely satisfactory. In selecting one of these needles for any procedure the most important thing is to have one long enough so that the entire needle is not buried in the tissues when the deepest injection is made. Needles usually break at the hub and if this occurs and they are not buried they can easily be withdrawn with the fingers. We have examined over 100 sacra and found great variation in their size, shape

and capacity of the canal, besides many pecular anomalies. In each lateral sacral foramen from 4 to 6 c.c of 1 per cent. novocaine is injected. In the sacral hiatus various amounts of 1 per cent. novocaine are injected *very slowly* and the perineum tested at intervals for anæsthesia. We have used as little as 20 c.c. and as much as 120 c.c. in the sacral canal to obtain perfect anæsthesia. Neither patient had any sign of shock and convalescence was uneventful. The usual amount used is 40 to 50 c.c. and the variations are due to the capacity of the canal. The action of the drug is physico-chemical,[14] the nerves taking up the solution, but due to their dural covering they have low permeability. Minor points of major clinical importance emphasized by Labat[17] are most valuable. Thompson,[28] Brenner,[2] Elliott,[10] and others have experimentally proven the levels within the spinal canal which are reached by various amounts of solution injected into the sacral hiatus. Clinically, however, the injection of amounts which should reach the thoracic nerves apparently does no harm. The capacity of the sacral canal, the slowness of injection, and the absorption may account for this. The general anæsthetic effect derived from the absorption of novocaine itself should not be overlooked because the mentality is often dulled in this manner.

Paravertebral anæsthesia for kidney and ureter operations is done according to Labat[16] by using 1 per cent. novocaine. This is usually supplemented by local injections along the line of incision. We are usually able to reach the kidney without any supplementary anæsthesia, but patients often complain of pain especially with stripping the peritoneum free from the anterior surface of the kidney, when freeing the kidney from adhesions, and occasionally when clamping and tying the pedicle. The utmost gentleness should be employed at all times as quick sponging, retracting or unnecessary roughness are usually painful.

Suprapubic cystotomies have been done both by local injections along the line of incision before each layer is cut and by nerve block of the entire field with 1 per cent. novocaine. We do not believe in injections along the line of incision because the reduced vitality of the tissue predisposes to infection, especially from the bladder, the muscles are not

so relaxed, and the anæsthesia is not so successful. In addition to the usual method we use superficial and deep injections across both recti muscles at the level of the umbilicus.

For bladder tumours and diverticuli, the sacral, transsacral and suprapubic nerve block are employed.

Scrotal cases are done by blocking the ilio-inguinal and ilio-hypogastric nerves medially to the anterior superior spine of the ileum, the genital branch of the genito-crural nerve at the internal inguinal ring or in the spermatic cord, and superficial block around the base of the scrotum. Nerve block at the base of the penis is done for circumcision or urethral repair.

Report of Cases.

The grading of the results into good, fair and bad as well as shock and post-operative complications has always been left to a disinterested person, attempting to get as near unbiased opinions as possible. Anæsthesias classed as good are those in which no general anæsthetic was given and they complained of no pain. The cases with fair results had some pain but none had more than an ounce of ether by the open method, while the unsatisfactory ones had between one ounce and enough for complete narcosis. Slight shock is regarded as those cases with rapid pulse, palpitation, mild dizziness, sweating and nausea, all of which were transitory. The interpretation of moderate shock is the development of vomiting, rapid weak pulse, profuse sweating, marked dizziness, paleness, tremor, and dyspnœa while those suffering from severe shock manifested a very weak thready pulse, pallor and occasionally unconsciousness with temporary collapse. All forms of shock were relieved with 10-20 minims of caffeine—sodium benzoate, 5-10 minims of adrenalin, or by smelling aromatic spirits of ammonia or ether. Supplementary anæsthesia includes preliminary analgesias as well as nitrous oxide gas or ether.

In the 199 cases of perineal prostatectomy the anæsthesia was successful in 176 or 88.4 per cent., was fair in 14, and poor in nine cases. Administration of sacral and transsacral anæsthesia with 1 per cent. novocaine has given us the

greatest percentage of successes. Six had mild shock while administering the anæsthesia, two moderate and two severe. Six had mild shock during the operation, two moderate shock lasting respectively one half hour and one hour, and two severe shock. Ten had mild shock after the operation, six moderate shock (at least one from hæmorrhage) and two severe shock both having received ether to a surgical degree. Four patients were given scopolamine 1/200 gr. with morphine sulphate 1/6 gr., one developing severe shock and one becoming delirious requiring general anæsthesia. Morphine sulphate, gr. 1/4, was given four other patients before operation. Fourteen were given some ether and one nitrous-oxide gas. There were nine deaths as follows:—

1. Died 18 hours after operation from acute dilatation of the heart. Regional anæsthesia was unsuccessful and ether was required to a surgical degree. Age 75.

2. Died 25 days after operation from heart block. All wounds were healed. Age 66.

3. Died 24 hours after operation from hæmorrhage. Had an extremely large prostate. Age 81.

4. Died 49 days after operation from pneumonia. Wounds were healed. Age 77.

5. Died 18 days after operation from pulmonary embolus. Age 63.

6. Died 19 hours after operation from hæmorrhage. Age 70.

7. Died 4 days after operation from uraemia. Age 68.

8. Died 13 days after operation from myocarditis. Age 66.

9. The patient entered the hospital with a complete retention of urine, having had intermittent catheterization for one month. A suprapubic cystotomy was performed with a very stormy convalescence. Two weeks later his prostate was removed by perineum. Five days after the operation, a cellulitis developed over the sacrum. This was incised and drained, but it kept spreading up to the 12th rib and down over the great trochanter. He died 13 days after prostatectomy. Post-mortem examination revealed extensive cellulitis around the sacrum from the buttocks to the angle of the scapulæ. There was no evidence of infection within the sacral canal. There was a large psoas abscess on the left side. At this

time in 1923 we were using the usual operating room prepared novocaine. Since then we have had it freshly prepared shortly before use by our own nurses.

The total mortality was 4.5 per cent., but the mortality from the anæsthesia was 0.5 per cent.

Of the 279 cases of suprapubic cystotomy the anæsthesia was successful in 228 or 81.7 per cent., was fair in 33, and poor in 18 cases. Administration of nerve block anæsthesia with 1 per cent. novocaine has given us the greatest percentage of successes. Fifteen had mild shock while administering the anæsthesia, five moderate and one severe. Eleven had mild shock during the operation, and two moderate shock each lasting 1 hour. Three had mild shock after the operation, one moderate and two severe. Thirty-five cases received some ether and five nitrous-oxide gas. Two needles were broken off and became buried in the tissues. One was easily found, but the other required further surgery for its removal.

There were 16 deaths as follows:—

1. Died 15 days after operation from uremia. Age 89.
2. Died 10 days after operation from cerebral hæmorrhage. Age 64.
3. Died 22 days after operation from uraemia. Age 72.
4. Died 24 days after operation from pneumonia. Age 75.
5. Died 15 days after operation from uremia. Age 64.
6. Died 4 days after operation from acute cardiac dilatation. Age 81.
7. Died 6 days after operation from embolus. Age 86.
8. Died 6 days after operation from pneumonia. Age 68.
9. Died 16 days after operation from general carcinomatosis. Age 40.
10. Died 6 days after operation from myocarditis. Age 65.
11. Died 3 days after operation from septicaemia. Age 57.
12. Died 2 days after operation from myocarditis. Age 74.
13. Died 2 days after operation from hæmorrhage of bladder tumour. Age 80.

The next three cases might possibly have been caused from the anæsthesia.

14. Died 5 days after operation with the diagnosis of paralytic ileus, acute dilatation of the stomach, and pneumonia. Age 54.

15. Died 24 hours after operation. Just as the operation was completed his pulse become thready, lips white and breathing difficult. A diagnosis of cardiac failure was made. Age 77.

16. Patient complained of nausea after the operation. In 3 days there was severe abdominal distention and he died 2 days later. There was a large hæmatoma on the anterior bladder walls at the time of the operation. Post-mortem examination revealed a thrombosis of the vesical and mesenteric veins; beginning gangrene of the jejunum and ileum; and hæmatoma of the pelvic soft tissues. The probable cause of death was the mesenteric thrombosis, which appeared to have been the result of thrombosis in the vesical wall. It produced ileus and obvious gangrene of the major share of the small intestine.

The total mortality is 5.7 per cent. while the possible deaths from anæsthesia are only 1 per cent. It is questionable whether any of these deaths were caused directly from the anæsthesia. The average age was 61.5 years.

The scrotal cases, 83 in number, include hydrocele, varicocele, and epididymectomy. The anæsthesia was successful in 62 or 74.5 per cent, was fair in 16, and poor in five cases. Administration of nerve block anæsthesia with 1 per cent. novocaine has given us the greatest percentage of successes. Fourteen required small amounts of ether, and eight cases manifested mild shock.

There were 28 cases of bladder tumours for resection or cautery including seven cases of suprapubic prostatectomy. The anæsthesia was successful in 17 or 60.7 per cent., was fair in six and poor in five cases. The combined use of sacral, transsacral and nerve block anæsthesia of the abdomen with 1 per cent. novocaine has given us the greatest percentage of successes. Nine were supplemented with some ether and two with nitrous-oxide gas. There was one moderate and one severe shock following suprapubic prostatectomies. The only death occurred from pulmonary embolus 12 days after operation.

The anæsthesia was successful in 27 or 73 per cent. of the 37 cases of Young's Punch operation, seven being fair and

three poor. Best results were obtained with sacral and transsacral injections of 1 per cent. novocaine. Eight cases required some ether. One patient died 24 hours after operation from hæmorrhage, and one ten days after operation from uræmia.

In 81 surgical kidney cases including nephrolithiasis, nephrectomy and nephropexy, the anæsthesia was successful in 41 or 50.6 per cent., was fair in 30 and poor in 10 cases. Thirty-five had an average of 1.7 oz. of ether by the open method, some requiring a few drops and some complete anæsthesia. Four were given nitrous-oxide gas.

Of 14 cases given preliminary medication of morphine, Gwathmey's analgesia, rectal ether or paraldehyde, seven required some additional ether during the procedure. There were four deaths, three from uræmia within 5 to 39 days, and one from pneumonia 16 days after operation.

Fifty-two cases of perineal section include urethrotomy. The anæsthesia was successful in 40, or 77 per cent., was fair in 11, and poor in one case. Sacral and transsacral injections of 1 per cent. novocaine gave us the greatest percentage of successes. Some ether was required by 10 patients. There were two deaths, one from anuria 10 days after an external urethrotomy, and one from general carcinomatosis 7 days following a perineal section.

Miscellaneous cases include all other operations, from perinephritic abscess to cystoscopy. Of the 192 miscellaneous cases, the anæsthesia was successful in 167 or 81.7 per cent., was fair in 17, and poor in eight cases. Complete ether anæsthesia was required in three cases while in 14 others some ether was needed. Severe novocaine intoxication with delirium lasted 20 minutes in one case, while another complained of severe pain over his sacral region for 10 hours. One death resulted 18 hours after operation from bladder hæmorrhage which could not be controlled. Another died 21 days after orchidectomy from general carcinomatosis, while the third died 34 days after nephrotomy from uræmia. The total mortality was 1.5 per cent.

In 1000 urological operations under regional anæsthesia administered by various methods, the anæsthesia was successful in 80.5 per cent., was fair in 13.6 per cent., and

poor in 5.9 per cent. One hundred and thirty-four cases exhibited some form of shock, either from the anæsthesia or the surgical procedure, with no deaths resulting from novocaine itself. One hundred and seventy-six required some supplementary anæsthesia. It is questionable if three of the deaths were caused from the anæsthesia. The death from cellulitis over the sacrum probably was due to improper sterilization of the novocaine solution, combined with the very low resistance of the patient. The total post-operative mortality was 3.7 per cent. The average age was 50.02 years.

Meeker and Scholl[25] state that the operative mortality in cases in which sacral anæsthesia was employed is less than half following prostatectomy under either ether or spinal anæsthesia.

Lowsley[21] has compared 100 cases of prostatectomy having general anæsthesia to 100 with regional anæsthesia with the following conclusions:

1. General anæsthesia mortality 14 per cent. compared to 3 per cent.

2. General anæsthesia shock 23 per cent. compared to four per cent.

3. General anæsthesia unusual hæmorrhage 31 per cent. compared to 2 per cent.

4. General anæsthesia average stay in hospital 33 days compared to 22.7 days.

These 1000 regional anæsthesias have been given by various surgeons, some at the time of operation, which accounts partly for the results. Experience and watching the minor points in administration cannot be over-emphasized. At present one surgeon takes complete charge of the anæsthesias, by which method better results should be obtained.

We believe in regional anæsthesia especially for urological cases. The blood pressure remains almost constant, which keeps the pressure within the kidneys unchanged and permits urine to be excreted from these organs uninterruptedly. Because of the constant blood pressure there is less bleeding, less shock, and lower mortality than with inhalation anæsthesia. Patients are permitted to take fluids before, during, and immediately after operation. Their

convalescence begins upon leaving the operating table. They avoid the post-operative slump always present with general anæsthesias. Respiratory infections are less frequent although not entirely eliminated. An attempt was made to get prostatics out of bed on the third day to prevent hypostatic pneumonia. Even if the patient suffers some pain or a small amount of ether is required, we still believe he had profitted by not having a general anæsthetic.

Conclusions.

1. Freshly prepared 1 per cent. novocaine (occasionally 0. 5 per cent.) without adrenalin is the solution of choice for regional anæsthesias using not more than 1 gram of novocaine to 100 pounds of body weight. Preliminary medication is rarely necessary. Deep rapid respiration during the surgical procedure is usually helpful. The solution must be injected *very slowly* into the sacral canal. The amount of solution used for sacral anæsthesia depends on the size of the canal and the threshold of pain in each individual.

2. Regional anæsthesia is applicable to all urological surgery and at least 80 per cent. of successful results should be expected. Experience in administration as well as the utmost care should be exercised as it is not without its dangers. Each patient should be watched carefully from the beginning of the anæsthesia for shock, which is not uncommon, and treatment at once instituted. The mortality with regional anæsthesia is decreased and from the anæsthetic itself is extremely small.

3. We have attempted many methods of administration with various drugs and although our results are gratifying, there is room for improvement in methods employed and less toxic drugs.

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Discussion of Paper by Dr. Henline.

Dr. Lowsley: Dr. Henline has presented a very careful study of the results with regional anæsthesia obtained in our clinic. As pointed out in the paper there is no question that a certain percentage of cases have toxic symptoms after the injection of novocaine. We feel that any advances in

this field are to come through the discovery of new drugs which are less toxic and equally or more efficient. After trying a large variety of drugs, strengths of solution, etc. we have dropped back at the present to plain 1 per cent. novocaine solution, without any additions, and feel that we get the best results with this preparation. I rather feel that tutocaine will not answer our problem. Beutaine is experimentally more toxic than cocaine. We had our accidents with its use and do not advise its employment except for mucous surfaces. We have used it upon mucous surfaces in thousands of cases without the slightest difficulty. Novocaine Borate is a new drug, not yet on the market. While plain novocaine takes from fifteen to twenty minutes to anæsthetize a mucous surface, novocaine borate will do so in one minute. This preparation cannot, however, be used for injections, since it causes necrosis.

Dr. Henline mentioned the fact that the relaxation is excellent under regional anæsthesia. Respirations are not forced and the muscles are at rest, and we feel that relaxation is greater under this than under any other form of anæsthesia.

Since we have had one man injecting the anæsthetic less time is consumed than formerly. We can now operate upon cases as fast as the operating room facilities will permit. There are no delays.

Dr.Henline has reported a very thorough study and is to be complimented upon the honesty of his report.

Dr. LABAT: I agree with Dr. Lowsley that Dr. Henline has presented a very excellent paper,—particularly since it is based upon such a large statistical study.

There has been a feeling that adrenalin has been responsible for the circulatory symptoms coming on after the anæsthetic solution has been injected. Since little or no adrenalin was used in the cases reported by Dr. Henline, the novocaine itself must be held responsible for any untoward effects observed. On account of the possibility of symptoms from the adrenalin itself, I now use but five drops in any case. When the solution containing the adrenalin is injected at a distance from the site of operation the vessels are more relaxed than normally and the bleeding more free,—the reverse of the condition in which the solution is deposited

locally,—and there is no fear, therefore, of post-operative bleeding following its use.

I was interested in hearing that Dr Henline had injected as much as 120c.c. into the caudal canal. Personally, I have never used nearly such large quantities, except when injecting to cure sciatic neuritis. I should like to ask Dr. Henline whether he observed any anæsthesia above the first sacral segment following the use of so large a quantity of solution.

Dr. HENLINE, closing: In the case referred to we were particularly anxious to obtain perfect anæsthesia. I took fully an hour in the injection of this case, giving but ten c.c. at a time, over the routine amount, then waiting to observe the results, then injecting a like amount and again waiting and testing for anæsthesia. After the 120 c.c. had been injected anæsthesia of the perineum was obtained. The patient was placed upon the operating room table and very carefully watched. There was no shock and not the slightest untoward symptom. The anæsthesia did not extend beyond the level of the first sacral segment.

We feel that the use of adrenalin at a distance from the site of operation has little local effect upon the blood vessels. The use of adrenalin has such a beneficial effect in cases of shock in raising the blood pressure, that we prefer to reserve the drug for such cases.

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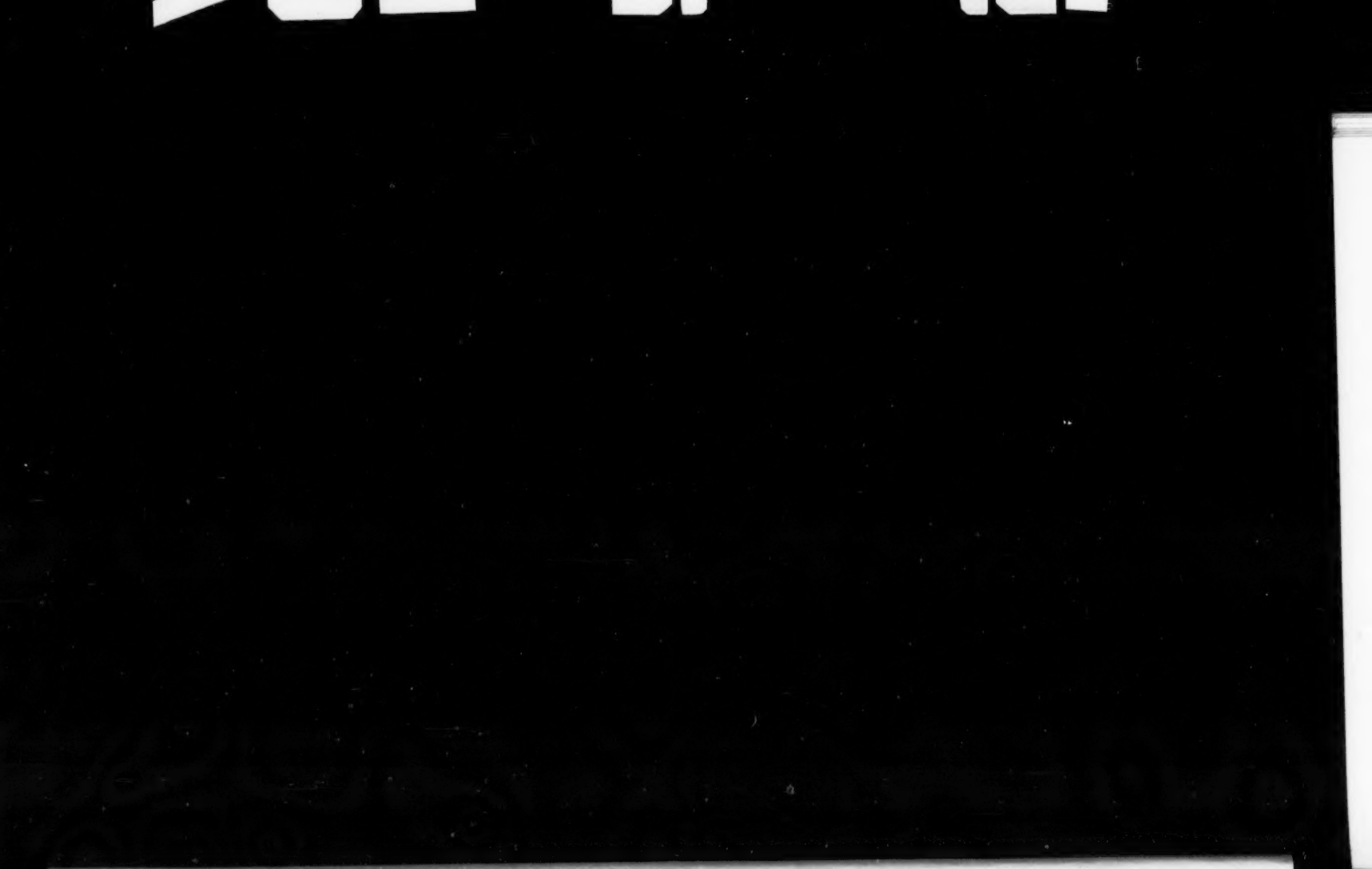
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